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(54) **AUTOMATED ROTARY MILKING SYSTEM**

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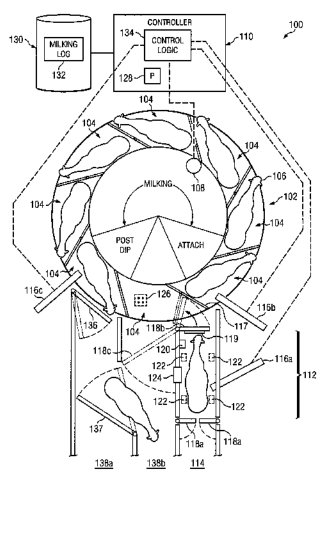
(57) **ABSTRACT**

A milking system includes a rotary milking platform having a plurality of milking stalls and a plurality of milking devices, each milking device configured for attachment to the teats of a dairy livestock located in a corresponding milking stall of the rotary milking platform. The system further includes one or more robotic devices operable to perform one or more functions, including preparing the teats of a dairy livestock for the attachment of a milking apparatus, attaching a milking apparatus to the teats of a dairy livestock, and applying a sanitizing agent to the teats of a dairy livestock subsequent to the removal of a milking apparatus from the teats of the dairy livestock. Each of the one or more functions performed by the one or more robotic devices is performed during a period of time when the rotary milking platform is substantially stationary.

8 Claims, 7 Drawing Sheets



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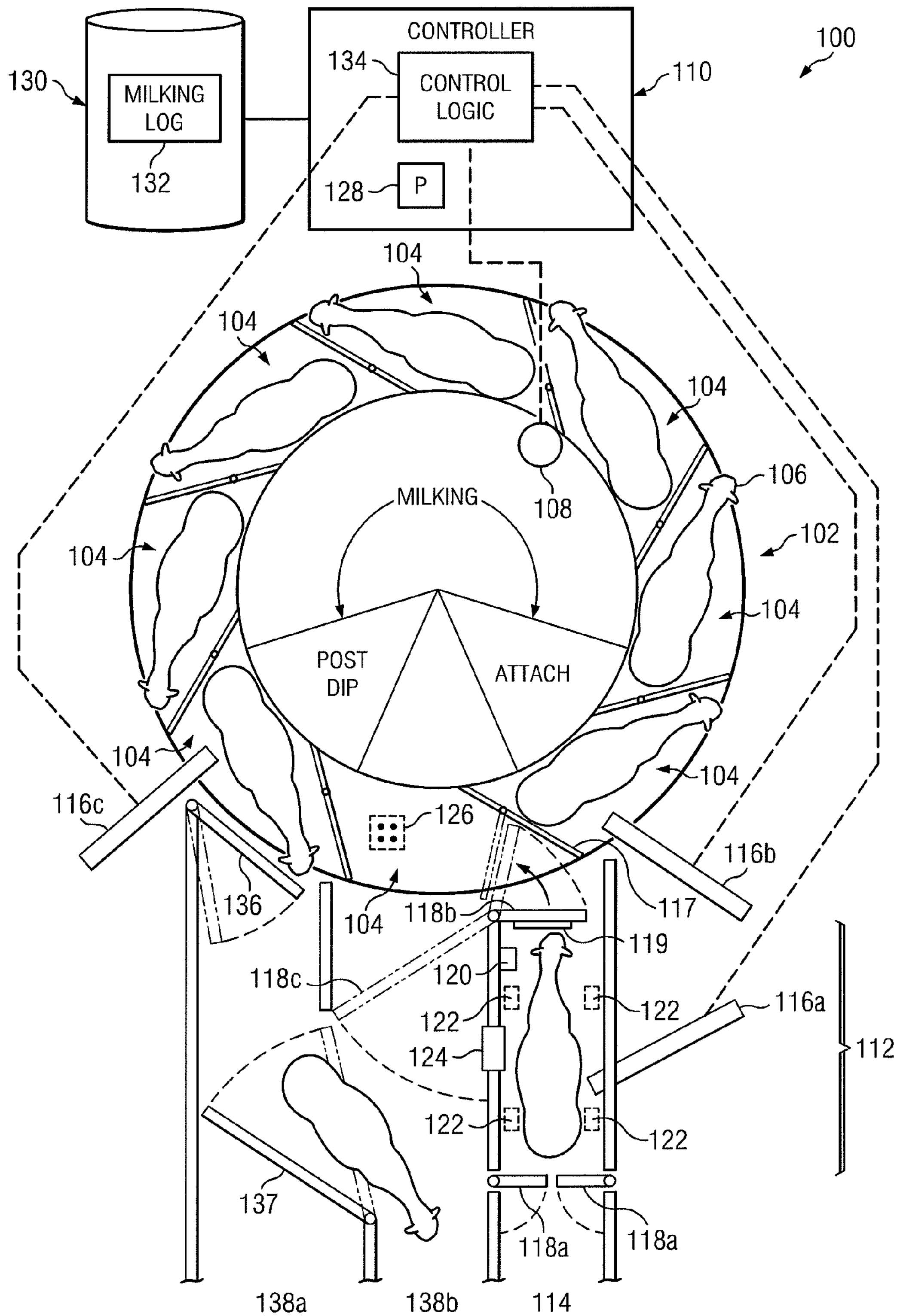
PCT Invitation to Pay Additional Fees and, Where Applicable, Protest Fee and Partial National Search Report for Application No. PCT/US2012/035079; 8 pages, Jul. 31, 2012.
PCT Notification of Transmittal of the International Search Report and the Written Opinion of the International Searching Authority for Application No. PCT/US2012/033892; 13 pages, Jul. 31, 2012.
PCT Notification of Transmittal of the International Search Report and the Written Opinion of the International Searching Authority for .Application No. PCT/US2012/035356; 14 pages, Jul. 31, 2012.
PCT Invitation to Pay Additional Fees and, Where Applicable, Protest Fee and Partial National Search Report for Application No. PCT/US2012/035107; 7 pages, Jul. 31, 2012.

* cited by examiner



100
130
MILKING LOG
132
CONTROLLER
134
CONTROL LOGIC
110
128
P
104
104
104
104
104
104
104
104
106
108
MILKING
102
POST DIP
ATTACH
116c
126
116b
136
118b
117
119
118c
120
122
122
116a
124
112
122
122
137
118a
118a
138a
138b
114

FIG. 1

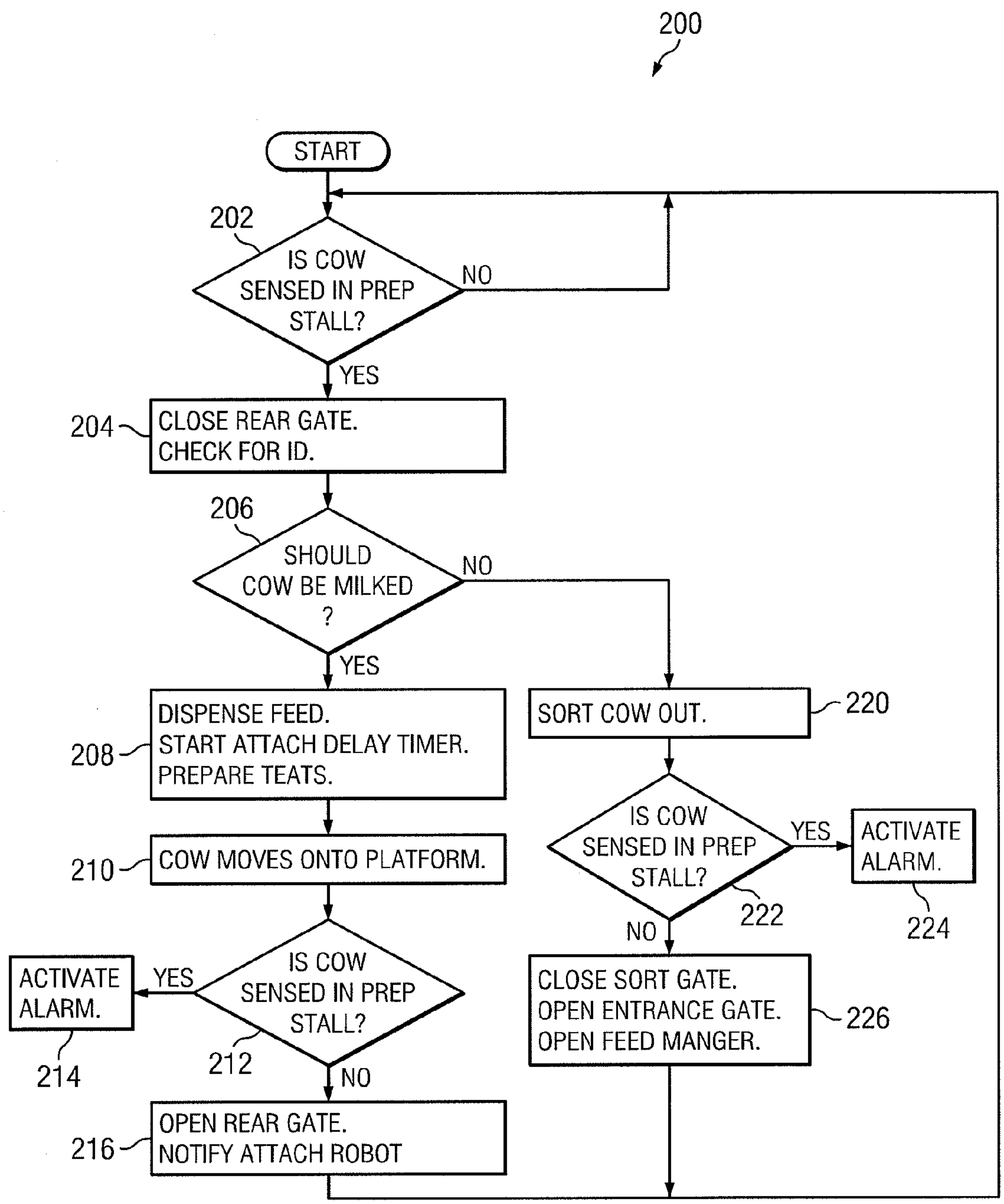

200
START
202
IS COW SENSED IN PREP STALL?
NO
YES
204
CLOSE REAR GATE.
CHECK FOR ID.
206
SHOULD COW BE MILKED ?
NO
YES
208
DISPENSE FEED.
START ATTACH DELAY TIMER.
PREPARE TEATS.
210
COW MOVES ONTO PLATFORM.
212
IS COW SENSED IN PREP STALL?
YES
NO
ACTIVATE ALARM.
214
216
OPEN REAR GATE.
NOTIFY ATTACH ROBOT
220
SORT COW OUT.
222
IS COW SENSED IN PREP STALL?
YES
NO
ACTIVATE ALARM.
224
226
CLOSE SORT GATE.
OPEN ENTRANCE GATE.
OPEN FEED MANGER.

FIG. 2

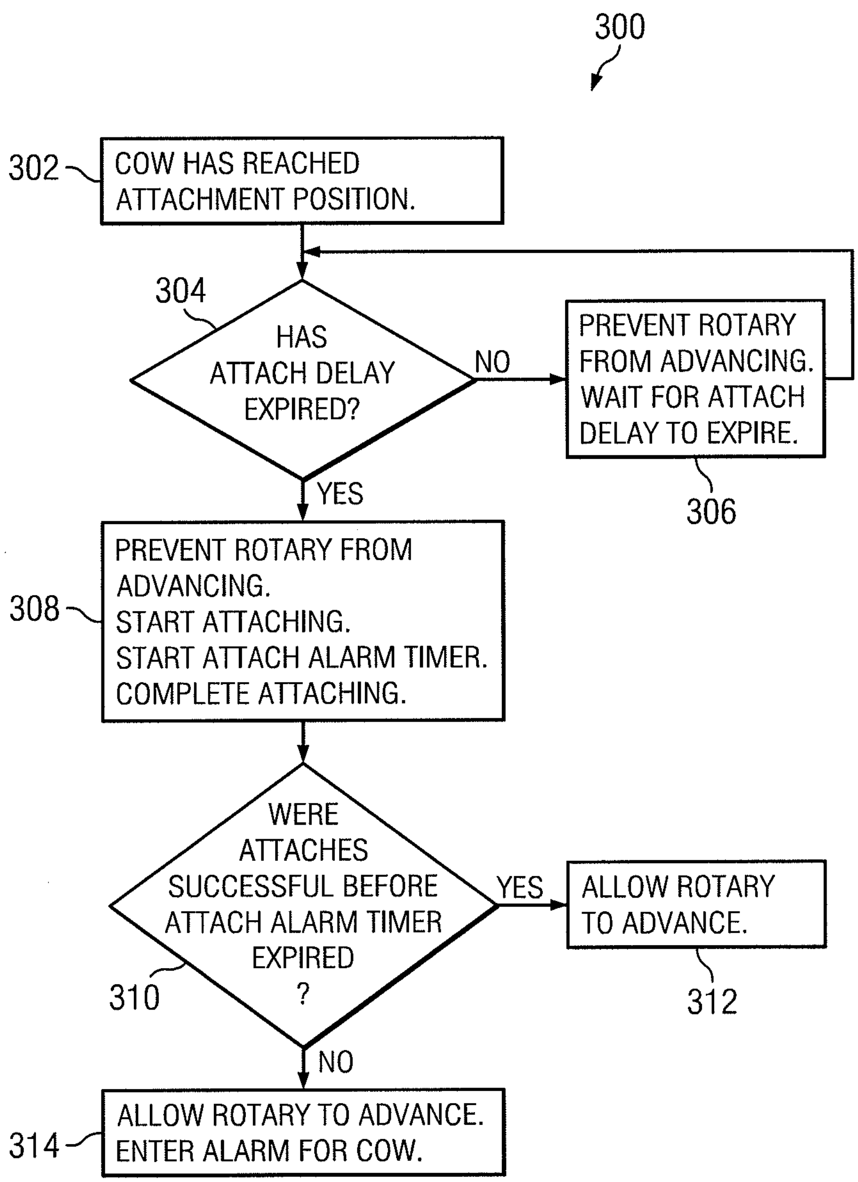

300
302
COW HAS REACHED ATTACHMENT POSITION.
304
HAS ATTACH DELAY EXPIRED?
NO
PREVENT ROTARY FROM ADVANCING. WAIT FOR ATTACH DELAY TO EXPIRE.
306
YES
308
PREVENT ROTARY FROM ADVANCING. START ATTACHING. START ATTACH ALARM TIMER. COMPLETE ATTACHING.
WERE ATTACHES SUCCESSFUL BEFORE ATTACH ALARM TIMER EXPIRED ?
310
YES
ALLOW ROTARY TO ADVANCE.
312
NO
314
ALLOW ROTARY TO ADVANCE. ENTER ALARM FOR COW.

FIG. 3

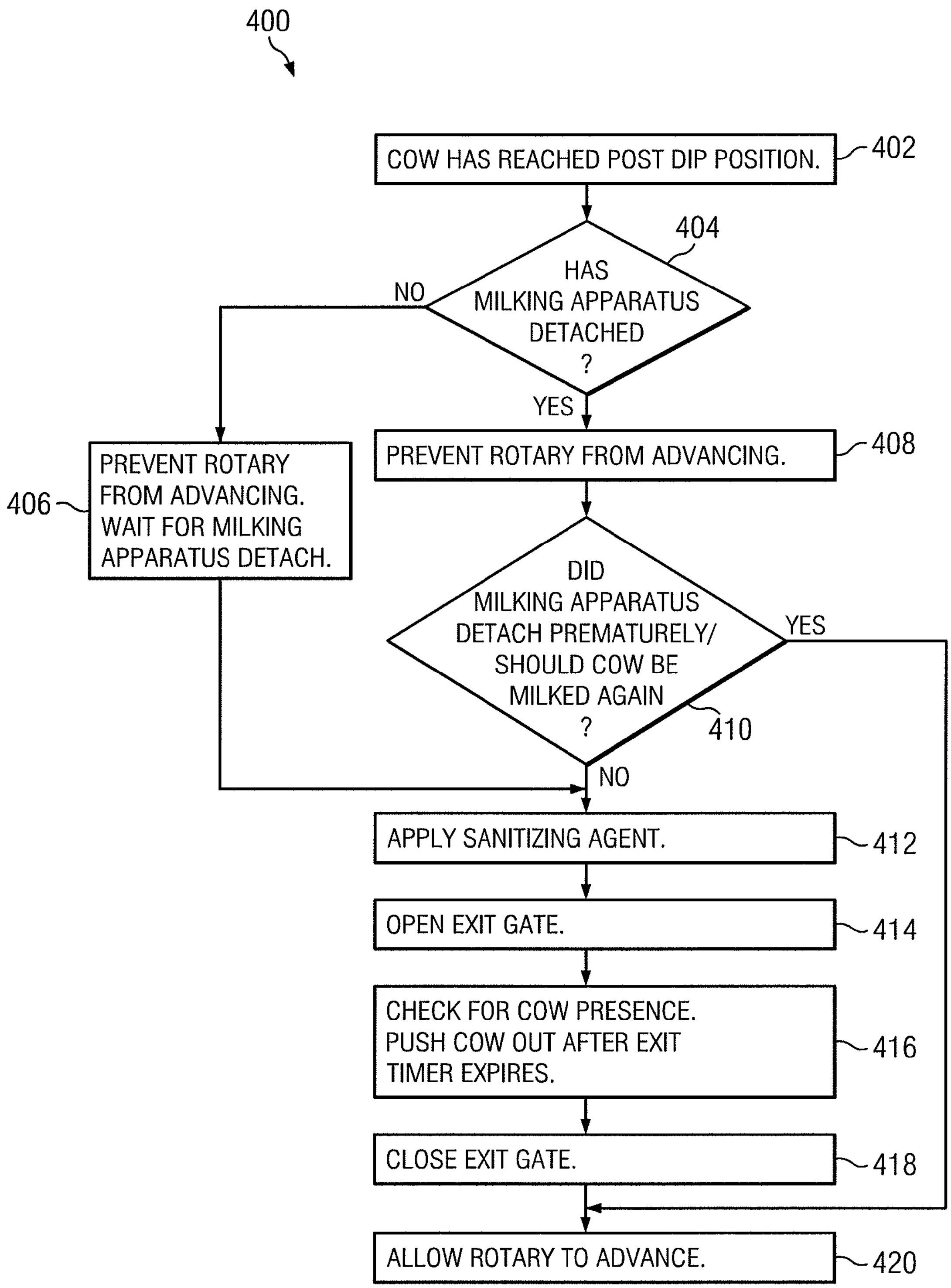
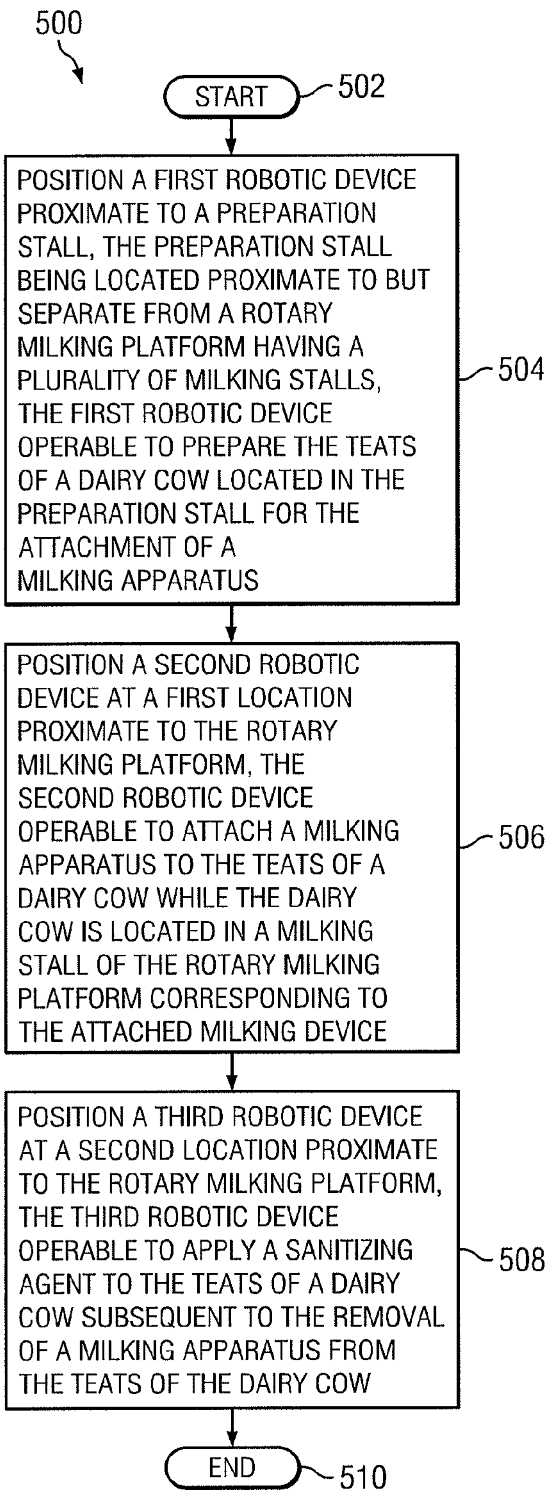
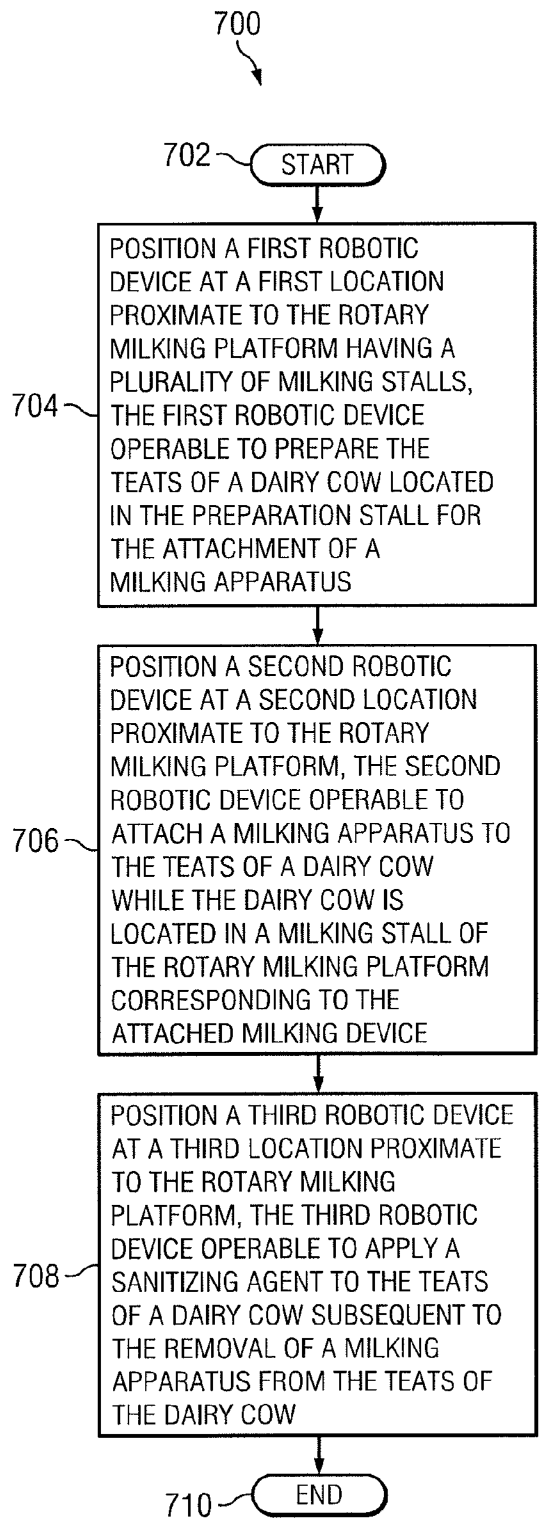

400
COW HAS REACHED POST DIP POSITION.
402
HAS MILKING APPARATUS DETACHED ?
404
NO
YES
PREVENT ROTARY FROM ADVANCING. WAIT FOR MILKING APPARATUS DETACH.
406
PREVENT ROTARY FROM ADVANCING.
408
DID MILKING APPARATUS DETACH PREMATURELY/ SHOULD COW BE MILKED AGAIN ?
410
YES
NO
APPLY SANITIZING AGENT.
412
OPEN EXIT GATE.
414
CHECK FOR COW PRESENCE. PUSH COW OUT AFTER EXIT TIMER EXPIRES.
416
CLOSE EXIT GATE.
418
ALLOW ROTARY TO ADVANCE.
420

FIG. 4


500
START
502
POSITION A FIRST ROBOTIC DEVICE PROXIMATE TO A PREPARATION STALL, THE PREPARATION STALL BEING LOCATED PROXIMATE TO BUT SEPARATE FROM A ROTARY MILKING PLATFORM HAVING A PLURALITY OF MILKING STALLS, THE FIRST ROBOTIC DEVICE OPERABLE TO PREPARE THE TEATS OF A DAIRY COW LOCATED IN THE PREPARATION STALL FOR THE ATTACHMENT OF A MILKING APPARATUS
504
POSITION A SECOND ROBOTIC DEVICE AT A FIRST LOCATION PROXIMATE TO THE ROTARY MILKING PLATFORM, THE SECOND ROBOTIC DEVICE OPERABLE TO ATTACH A MILKING APPARATUS TO THE TEATS OF A DAIRY COW WHILE THE DAIRY COW IS LOCATED IN A MILKING STALL OF THE ROTARY MILKING PLATFORM CORRESPONDING TO THE ATTACHED MILKING DEVICE
506
POSITION A THIRD ROBOTIC DEVICE AT A SECOND LOCATION PROXIMATE TO THE ROTARY MILKING PLATFORM, THE THIRD ROBOTIC DEVICE OPERABLE TO APPLY A SANITIZING AGENT TO THE TEATS OF A DAIRY COW SUBSEQUENT TO THE REMOVAL OF A MILKING APPARATUS FROM THE TEATS OF THE DAIRY COW
508
END
510
FIG. 5


700
702
START
704
POSITION A FIRST ROBOTIC DEVICE AT A FIRST LOCATION PROXIMATE TO THE ROTARY MILKING PLATFORM HAVING A PLURALITY OF MILKING STALLS, THE FIRST ROBOTIC DEVICE OPERABLE TO PREPARE THE TEATS OF A DAIRY COW LOCATED IN THE PREPARATION STALL FOR THE ATTACHMENT OF A MILKING APPARATUS
706
POSITION A SECOND ROBOTIC DEVICE AT A SECOND LOCATION PROXIMATE TO THE ROTARY MILKING PLATFORM, THE SECOND ROBOTIC DEVICE OPERABLE TO ATTACH A MILKING APPARATUS TO THE TEATS OF A DAIRY COW WHILE THE DAIRY COW IS LOCATED IN A MILKING STALL OF THE ROTARY MILKING PLATFORM CORRESPONDING TO THE ATTACHED MILKING DEVICE
708
POSITION A THIRD ROBOTIC DEVICE AT A THIRD LOCATION PROXIMATE TO THE ROTARY MILKING PLATFORM, THE THIRD ROBOTIC DEVICE OPERABLE TO APPLY A SANITIZING AGENT TO THE TEATS OF A DAIRY COW SUBSEQUENT TO THE REMOVAL OF A MILKING APPARATUS FROM THE TEATS OF THE DAIRY COW
710
END
FIG. 7

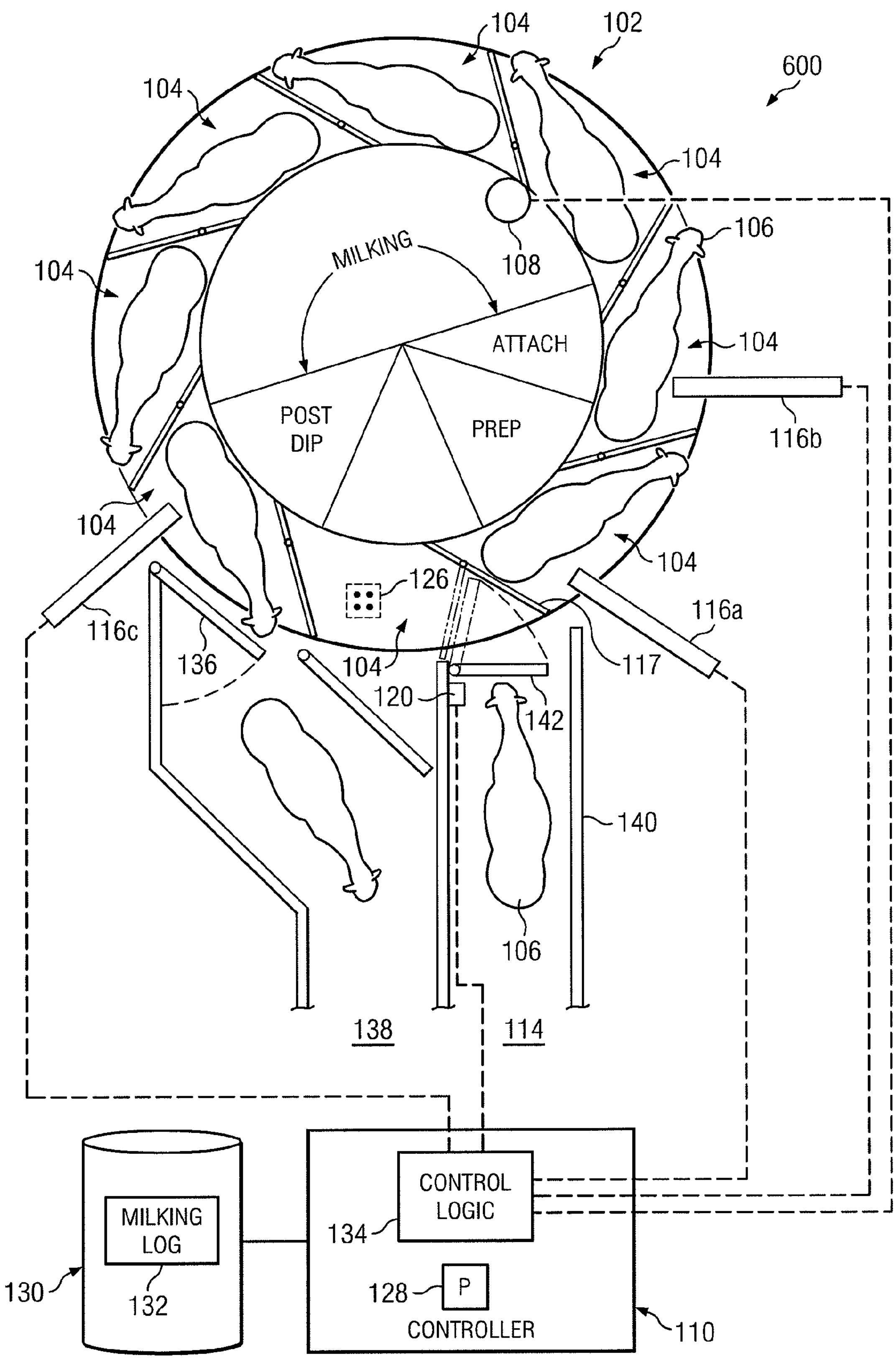

600
102
104
106
108
MILKING
ATTACH
PREP
POST DIP
116a
116b
116c
117
120
126
136
140
142
138
114
CONTROL LOGIC
134
P
128
CONTROLLER
110
MILKING LOG
132
130

FIG. 6

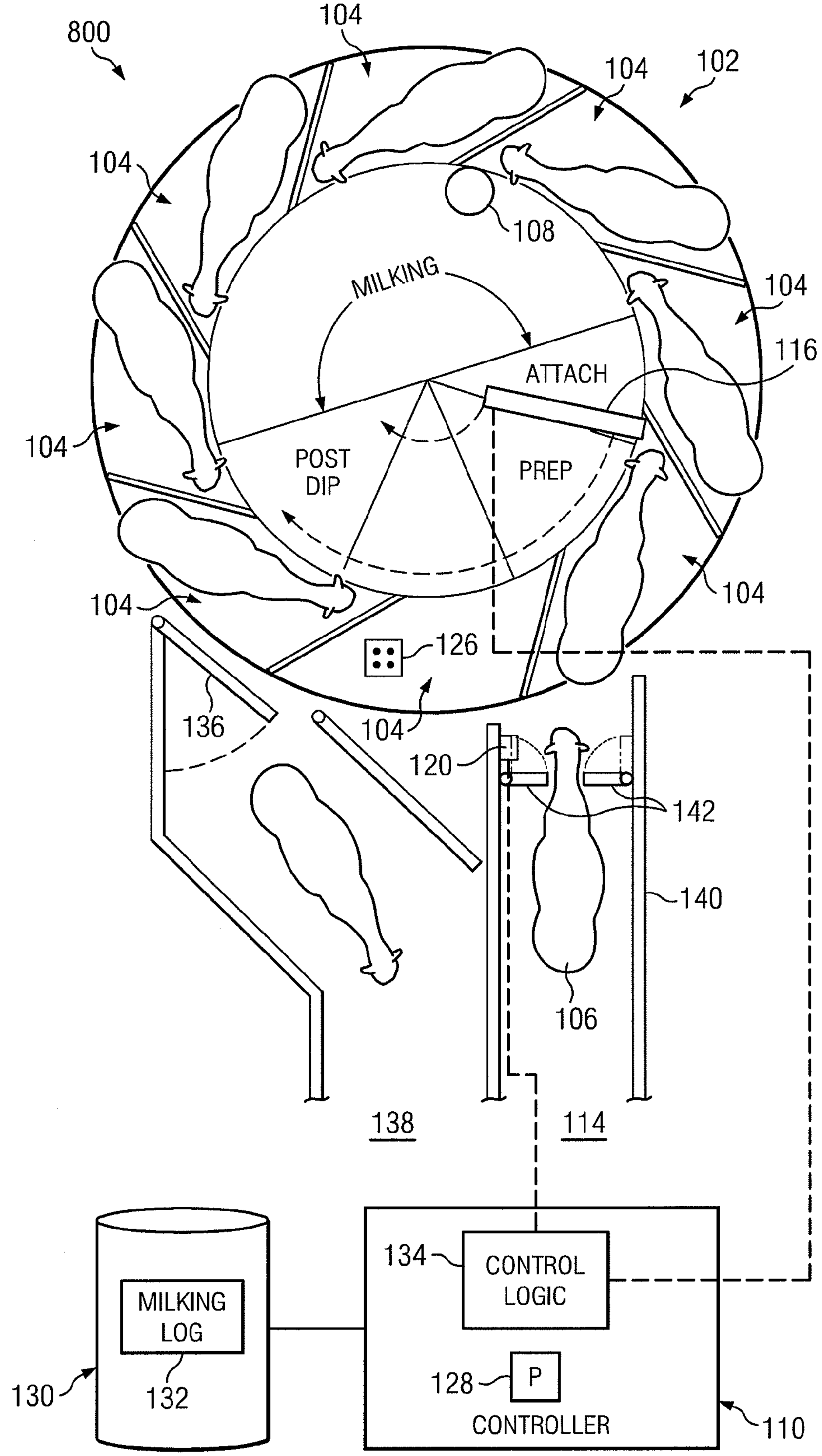

800
104
102
104
104
108
MILKING
104
116
ATTACH
104
POST
DIP
PREP
104
104
126
136
104
120
142
140
106
138
114
MILKING
LOG
134
CONTROL
LOGIC
128
P
CONTROLLER
130
132
110

FIG. 8

AUTOMATED ROTARY MILKING SYSTEM

TECHNICAL FIELD

This invention relates generally to dairy farming and more particularly to an automated rotary milking system.

BACKGROUND OF THE INVENTION

Over time, the size and complexity of dairy milking operations has increased. Accordingly, the need for efficient and scalable systems and methods that support dairy milking operations has also increased. Systems and methods supporting dairy milking operations, however, have proven inadequate in various respects.

SUMMARY OF THE INVENTION

According to embodiments of the present disclosure, disadvantages and problems associated with previous systems supporting dairy milking operations may be reduced or eliminated.

In certain embodiments, a milking system includes a rotary milking platform having a plurality of milking stalls and a plurality of milking devices, each milking device configured for attachment to the teats of a dairy livestock located in a corresponding milking stall of the rotary milking platform. The system further includes one or more robotic devices operable to perform one or more functions, including preparing the teats of a dairy livestock for the attachment of a milking apparatus, attaching a milking apparatus to the teats of a dairy livestock, and applying a sanitizing agent to the teats of a dairy livestock subsequent to the removal of a milking apparatus from the teats of the dairy livestock. Each of the one or more functions performed by the one or more robotic devices is performed during a period of time when the rotary milking platform is substantially stationary.

Particular embodiments of the present disclosure may provide one or more technical advantages. For example, the use of robotic devices in conjunction with a rotary milking platform may increase the throughput of the milking system, thereby increasing the overall milk production of the milking platform. Additionally, because the various milking functions are performed while the milking platform is substantially stationary, the number of robotic devices needed to perform those functions may be minimized. As a result, the upfront cost associated with the milking system may be reduced. Furthermore, because the various milking functions are performed by one or more robotic devices as opposed to human laborers (which may be expensive and/or difficult to find), the cost associated with operating the milking system may be reduced.

Certain embodiments of the present disclosure may include some, all, or none of the above advantages. One or more other technical advantages may be readily apparent to those skilled in the art from the figures, descriptions, and claims included herein.

BRIEF DESCRIPTION OF THE DRAWINGS

To provide a more complete understanding of the present invention and the features and advantages thereof, reference is made to the following description taken in conjunction with the accompanying drawings, in which:

FIG. **1** illustrates a top view of an example automated rotary milking system, according to certain embodiments of the present disclosure;

FIG. **2** illustrates an example method of operation associated with a preparation robot of the example automated rotary milking system of FIG. **1**, according to certain embodiments of the present disclosure;

FIG. **3** illustrates an example method of operation associated with an attachment robot of the example automated rotary milking system of FIG. **1**, according to certain embodiments of the present disclosure;

FIG. **4** illustrates an example method of operation associated with a post dip robot of the example automated rotary milking system of FIG. **1**, according to certain embodiments of the present disclosure;

FIG. **5** illustrates an example method for installation of the automated rotary milking system depicted in FIG. **1**, according to certain embodiments of the present disclosure;

FIG. **6** illustrates a top view of an alternative example automated rotary milking system, according to certain embodiments of the present disclosure;

FIG. **7** illustrates an example method for installation of the automated rotary milking system depicted in FIG. **6**, according to certain embodiments of the present disclosure; and

FIG. **8** illustrates a top view of an additional alternative example automated rotary milking parlor system, according to certain embodiments of the present disclosure.

DETAILED DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates a top view of an example automated rotary milking system **100**, according to certain embodiments of the present disclosure. System **100** includes a rotary milking platform **102** having a number of milking stalls **104** each configured to facilitate milking of dairy livestock **106**. A rotary drive mechanism **108** coupled to rotary milking platform **102** is operable to control the rotation of rotary milking platform **102** (e.g., in response to signals received from controller **110**). System **100** further includes a preparation stall **112** positioned between a holding pen **114** and one or more milking stalls **104** of rotary milking platform **102**, and one or more robotic devices **116** positioned proximate to rotary milking platform **102** and/or preparation stall **112**. Although this particular implementation of system **100** is illustrated and primarily described, the present invention contemplates any suitable implementation of system **100** according to particular needs. Additionally, although the present disclosure contemplates system **100** facilitating the milking of any suitable dairy livestock **106** (e.g., cows, goats, sheep, water buffalo, etc.), the remainder of this description is detailed with respect to dairy cows.

Rotary milking platform **102** may include any suitable combination of structure and materials forming a circular platform having a number of milking stalls **104** positioned around the perimeter of the platform such that the milking stalls **104** rotate about a center point as dairy cows in milking stalls **104** are milked. As one particular example, rotary milking platform **102** may have a diameter of one hundred fifty-five inches and may include eight equally-sized milking stalls **104** positioned around the perimeter of the platform. In certain embodiments, each milking stall **104** may include a stall gate **117** configured to control the flow of dairy cows **106** into the milking stall **104** from preparation stall **112**. Additionally, stall gates **117** may each be coupled to one or more actuators operable to open/close stall gates **117** in response to receipt of a signal from controller **110** (as described in further detail below). Although a rotary milking platform **102** having a particular size and a particular number of stalls **104** is illustrated, the present disclosure contemplates a rotary milking platform **102** having any suitable size and including any suitable number of stalls **104**.

Rotary milking platform **102** may be coupled (e.g., via one or more gears or any other suitable power transmission mechanism) to a rotary drive mechanism **108**. Rotary drive mechanism **108** may include a motor (e.g., a hydraulic motor, an electric motor, or any other suitable motor) operable to impart a variable amount of rotational force on rotary milking platform **102** via one or more gears. In certain embodiments, rotary drive mechanism **108** may be operable to start/stop the rotation of rotary milking platform **102** in response to receipt of a signal from controller **110** (as described in further detail below).

Preparation stall **112** may be positioned proximate to both holding pen **114** and rotary milking platform **102** such that a dairy cow **106** in holding pen **114** may enter preparation stall **112** prior to entering a milking stall **104** of rotary milking platform **102**. Preparation stall **112** may include any suitable number of walls constructed of any suitable materials arranged in any suitable configuration operable to prevent movement of dairy cows **106**. For example, the walls of preparation stall **112** may each include any number and combination of posts, rails, tubing, rods, connectors, cables, wires, and/or beams operable to form a substantially planar barricade such as a fence, wall, and/or other appropriate structure suitable to prevent movement of dairy cows **106**.

Preparation stall **112** may include an entrance gate **118*a*** controlling the flow of dairy cows **106** into preparation stall **112** from holding pen **114**, an exit gate **118*b*** controlling the flow of dairy cows **106** from preparation stall **112** into a milking stall **104** of rotary milking platform **102**, and a sorting gate **118*c*** allowing dairy cows to return to holding pen **114**. In certain embodiments, gates **118** may each be coupled to one or more actuators operable to open/close gates **118** in response to receipt of a signal from controller **110** (as described in further detail below).

In certain embodiments, preparation stall **112** may include a feed manger **119** (e.g., coupled to exit gate **118*b***). Feed manger **119** may be operable to dispense feed (e.g., in response to receipt of a signal from controller **110**) in order to entice dairy cows **106** to enter preparation stall **112**.

In certain embodiments, preparation stall **112** may additionally include an identification device **120** operable to identify a dairy cow located in preparation stall **112**. For example, identification device **120** may comprise any suitable radio-frequency identification (RFID) reader operable to read an RFID tag of a dairy cow **106** (e.g., an RFID ear tag). In certain embodiments, identification device **120** may communicate the identity of a dairy cow **106** located in preparation stall **112** (e.g., a tag number) to controller **110**, which may determine (e.g., based on a milking log **132** stored in memory **130**) if it is an appropriate time to milk the identified dairy cow **106** (as described in further detail below).

In certain embodiments, preparation stall **112** may additionally include one or more load cells **122** (e.g., one or more scales or other suitable devices) operable to determine a weight for a dairy cow located in the preparation stall **112** and/or a vision system **124** (e.g., a camera or other suitable device) operable to determine the size of a dairy cow located in preparation stall **112**. Load cells **122** and vision system **124** may each be communicatively coupled (e.g., via wireless or wireline communication) to controller **110** such that a determined weight and size associated with a dairy cow **106** in preparation stall **112** may be communicated to controller **110**. Controller **110** may associate the determined weight and size of the dairy cow **106** with the identification of the dairy cow **106** such that information associated with the dairy cow **106** stored in milking log **132** may be updated.

Robotic devices **116** may each comprise any suitable robotic device constructed from any suitable combination of materials (e.g., controllers, actuators, software, hardware, firmware, etc.) operable to perform certain functions associated with the milking of dairy cows **106** in an automated manner (as described in further detail below). In certain embodiments, robotic devices **116** may include an arm operable to rotate about a pivot point such that robotic devices **116** may extend beneath a dairy cow **106** to perform functions associated with the milking of the dairy cows **106** and retract from beneath the dairy cow **106** once those functions have been completed.

In certain embodiments, robotic devices **116** of system **100** may include a preparation robot **116*a***, an attachment robot **116*b***, and a post dip robot **116*c***. Preparation robot **116*a*** may be positioned proximate to preparation stall **112** such that preparation robot **116*a*** may extend and retract from beneath a dairy cow **106** located in preparation stall **112**. Preparation robot **116*a*** may be operable to prepare the teats of a dairy cow **106** located in preparation stall **112** for the attachment of a milking apparatus **126**. In certain embodiments, preparing the teats of a dairy cow **106** for the attachment of a milking apparatus **126** may include applying a sanitizing agent to the teats of a dairy cow **106**, cleaning the teats of the dairy cow, stimulating the teats of the dairy cow **106**, and any other suitable procedures.

Attachment robot **116*b*** may be positioned proximate to rotary milking platform **102** such that attachment robot **116*b*** may extend and retract from beneath a dairy cow **106** located in a milking stall **104** located at a first rotational position of rotary milking platform **102** (the "attach position"). Attachment robot **116*b*** may be operable to perform functions including attaching a milking apparatus **126** to the teats of a dairy cow **106** in the milking stall **104** located at the attach position. The attached milking apparatus **126** may be stored beneath the floor of the milking stall **104** (or at any other suitable location) such that the milking apparatus is accessible by attachment robot **116*b***.

Post dip robot **116*c*** may be positioned proximate to rotary milking platform **102** such that post dip robot **116*c*** may extend and retract from beneath a dairy cow **106** located in a milking stall **104** located at a second rotational position of rotary milking platform **102** (the "post dip position"). Post dip robot **116*c*** may be operable to perform functions including applying a sanitizing agent to the teats of a dairy cow **106** in the milking stall **104** located at the post dip position (subsequent to the removal of a milking apparatus **126** from the teats of the dairy cow **106**). In certain embodiments, each of the above-described functions performed by preparation robot **116*a***, attachment robot **116*b***, and post dip robot **116*c*** are performed while rotary milking platform **102** is substantially stationary (as controlled by controller **110** in conjunction with rotary drive mechanism **108**, as described in further detail below).

In certain embodiments, various components of system **100** (e.g., rotary drive mechanism **108**, actuators coupled to gates **118** of preparation stall **112**, and robotic devices **116**) may each be communicatively coupled (e.g., via a network facilitating wireless or wireline communication) to controller **110**, which may initiate/control the automated operation of those devices (as described in further detail below). Controller **110** may include one or more computer systems at one or more locations. Each computer system may include any appropriate input devices (such as a keypad, touch screen, mouse, or other device that can accept information), output devices, mass storage media, or other suitable components for receiving, processing, storing, and communicating data. Both the input devices and output devices may include fixed or removable storage media such as a magnetic computer disk, CD-ROM, or other suitable media to both receive input from and provide output to a user. Each computer system may include a personal computer, workstation, network computer, kiosk, wireless data port, personal data assistant (PDA), one or more processors within these or other devices, or any other suitable processing device. In short, controller **110** may include any suitable combination of software, firmware, and hardware.

Controller **110** may additionally include one or more processing modules **128**. Processing modules **128** may each include one or more microprocessors, controllers, or any other suitable computing devices or resources and may work, either alone or with other components of system **100**, to provide a portion or all of the functionality of system **100** described herein.

Controller **110** may additionally include (or be communicatively coupled to via wireless or wireline communication) memory **130**. Memory **130** may include any memory or database module and may take the form of volatile or non-volatile memory, including, without limitation, magnetic media, optical media, random access memory (RAM), read-only memory (ROM), removable media, or any other suitable local or remote memory component. Memory **130** may store a milking log **132**, which may be a table listing each dairy cow **106** which may enter a milking stall **104** of rotary milking platform **102** along with information associated with each dairy cow **106** (e.g., milking history, weight, and size). Although milking log **132** is depicted and primarily described as being stored in memory **130**, the present disclosure contemplates milking log **132** being stored at any other suitable location in system **100**.

In certain embodiments, controller **110** may include control logic **134** (e.g., stored in memory module **130**), which may include any information, logic, and/or instructions stored and/or executed by controller **110** to control the automated operation of system **100**, as described below. For example, in response to control logic **134**, processor **128** may (1) communicate signals to actuators coupled to gates **118** to initiate opening/closing of those gates, (2) communicate signals to rotary drive mechanism **108** to initiate the starting/stopping of rotary milking platform **102**, and (3) communicate signals to robotic devices **116** to initiate performance of the above-described functions associated with those robotic devices **116**. Additionally, in response to control logic **134**, processor **128** may be operable to update milking log **132** of in response to information associated with dairy cows **106** received from various components of system **100** (e.g., identification device **120**, load cells **122**, vision system **124**, and milking apparatus **126**).

In operation of an example embodiment of system **100**, controller **110** may receive a signal indicating the presence of a dairy cow **106** located in preparation stall **112**. The signal indicating the presence of a dairy cow **106** in preparation stall **112** may be received from a presence sensor associated with preparation stall **112** or from any other suitable component of system **100** (e.g., identification device **120**). Additionally, controller **110** may receive a signal from identification device **120**, which may include the identity (e.g., tag number) of the dairy cow **106**. Based on the identity of the dairy cow **106** in preparation stall **112**, controller **110** may determine if it is an appropriate time to milk the identified dairy cow **106**.

For example, controller **110** may access milking log **132** stored in memory **130**, which may include the date/time that the identified dairy cow **106** was last milked. If it is determined that the amount of time elapsed since the identified dairy cow **106** was last milked is greater than a predefined amount of time, controller **110** may determine that it is an appropriate time to milk the identified dairy cow **106**; otherwise, controller **110** may determine it is not an appropriate time to milk the identified dairy cow **106**. As an additional example, controller **110** may access milking log **132** stored in memory **130**, which may include the amount of milk collected from the identified dairy cow **106** during a previous time period (e.g., the previous eight to twelve hours). If the amount of milk collected during the previous time period is less than a predefined amount associated with the identified dairy cow **106**, controller **110** may determine that it is an appropriate time to milk the identified dairy cow **106**; otherwise, controller **110** may determine it is not an appropriate time to milk the identified dairy cow **106**.

Additionally, controller **110** may be operable to update information associated with the identified dairy cow **106** in milking log **132** based on information received from additional components of system **100**. For example, controller **110** may be operable to update the weight of the identified dairy cow **106** based on information received from load cells **122** of preparation stall **112**. Additionally, controller **110** may be operable to update the size of the identified dairy cow **106** based on information received from vision system **124** of preparation stall **112**.

If controller **110** determines that it is not an appropriate time to milk the identified dairy cow **106**, controller **110** may generate a signal to be communicated to an actuator coupled to sorting gate **118***c* of preparation stall **112**, the communicated signal initiating the opening of sorting gate **118***c* such that the identified dairy cow **106** may return to holding pen **114** to be milked at a later time.

If controller **110** determines that it is an appropriate time to milk the identified dairy cow **106**, feed manger **119** (e.g., in response to a signal received from controller **110**) may open in order to provide feed to the identified dairy cow **106**. Additionally, preparation robot **116***a* (e.g., in response to a signal received from controller **110**) may position itself beneath the identified dairy cow **106** and prepare the teats of the identified dairy cow **106** for the attachment of a milking apparatus **126** (e.g., by applying a sanitizing agent to the teats of the identified dairy cow **106**, cleaning the teats of the identified dairy cow **106**, and stimulating the teats of the identified dairy cow **106**). Once preparation robot **116***a* has prepared the teats of the identified dairy cow **106**, controller **110** may generate signals to be communicated to actuators coupled to exit gate **118***b* and the stall gate **117** of the milking stall **104** located adjacent to preparation stall **112**, the communicated signals initiating the opening of exit gate **118***b* and the stall gate **117** such that the identified dairy cow **106** may enter a milking stall **104** of rotary milking platform **102**. Once the identified dairy cow **106** has fully entered a milking stall **104**, controller **110** may (1) communicate signals to the actuators coupled exit gate **118***b* and stall gate **117**, the signals initiating the closing of exit gate **118***b* and stall gate **117**, (2) communicate a signal to entrance gate **118***a* of preparation stall **112**, the signal initiating the opening of entrance gate **118***a* such that a next dairy cow **106** may enter preparation stall **112**, and (3) communicate a signal to rotary drive mechanism **108**, the signal initiating an incremental rotation of rotary milking platform **102** such that the milking stall **104** in which the identified dairy cow **106** is located moves to a first rotational position of rotary milking platform **102** (the "attach" position).

With the rotary milking platform **102** being substantially stationary and the milking stall **104** of the identified dairy cow **106** being located at the attach position, attachment robot **116***b* (e.g., in response to a signal received from controller **110**) may position itself beneath the identified dairy cow **106** and attach a milking apparatus **126** to the teats of the identified dairy cow **106**. For example, attachment robot **116***b* may access a milking apparatus **126** corresponding to the milking stall **104** of the identified dairy cow **106** from a known storage position within the milking stall **104** (e.g., beneath the floor of the milking stall **104**) and attach the accessed milking apparatus **126** to the teats of the identified dairy cow **106**.

Once attachment robot **116***b* has attached the milking apparatus **126** to the teats of the identified dairy cow **106** (and possibly after a next dairy cow **106** has fully entered a milking stall **104** from preparation stall **112**, as described above), controller **110** may communicate a signal to rotary drive mechanism **108**, the signal initiating a further incremental rotation of rotary milking platform **102** (e.g., an amount corresponding to a single milking stall **104**). As rotary milking platform **102** completes subsequent incremental rotations, the identified dairy cow **106** is milked, with the milking apparatus **126** being detached and withdrawn (e.g., by retracting the milking apparatus **126** to the known storage position within the milking stall **104**) once milking is complete. With milking complete, the identified dairy cow **106** continues to complete incremental rotations until the milking stall **104** in which the identified dairy cow **106** is located reaches a second rotational position (the "post dip position").

With the rotary milking platform **102** being substantially stationary and the milking stall **104** of the identified dairy cow **106** being located at the post dip position, post dip robot **116***c* (e.g., in response to a signal received from controller **110**) may position itself beneath the identified dairy cow **106** and apply a sanitizing agent to the teats of the identified dairy cow **106**. In certain embodiments, the post dip position may be located adjacent to an exit gate **136** leading to an exit pen **138**. Once post dip robot **116***c* has applied the sanitizing agent, control logic **134** may communicate a signal to an actuator coupled to exit gate **136**, the signal initiating the opening of exit gate **136** such that the identified dairy cow **106** may exit the milking stall **104** and enter the exit pen **138**. In certain embodiments, exit pen **138** may be divided into an exit pen **138***a* and a catch pen **138***b*, and an exit sorting gate **137** may facilitate the sorting of exiting dairy cows between exit pen **138***a* and catch pen **138***b*. If controller **110** determines that the identified cow **106** was not fully milked or that the milking apparatus **126** was detached prematurely (e.g., using historical milking data stored in milking log **132**), controller **110** may not communicate a signal to the actuator coupled to exit gate **136**, forcing the identified dairy cow **106** to complete another milking rotation (as described above).

Although a particular implementation of system **100** is illustrated and primarily described, the present disclosure contemplates any suitable implementation of system **100**, according to particular needs. Moreover, although robotic devices **116** of system **100** have been primarily described as being located at particular positions relative to milking platform **102** and/or preparation stall **112**, the present disclosure contemplates robotic devices **116** being positioned at any suitable location, according to particular needs.

FIG. **2** illustrates an example method of operation **200** associated with preparation robot **116***a* of system **100**, according to certain embodiments of the present disclosure. At step **202**, controller **110** determines whether a dairy cow **106** is present in preparation stall **112** (e.g., based on a signal received from identification device **120**, load cells **122**, vision system **124**, or any other suitable presence sensor). At step **204**, controller **110** generates a signal to be communicated to an actuator coupled to entrance gate **118***a* of preparation stall **112**, the communicated signal initiating closing of entrance gate **118***a* such that the dairy cow **106** may not exit preparation stall **112**. Additionally, at step **204**, controller **110** waits for receipt of a signal from identification device **120** identifying the dairy cow **106** located in preparation stall **112** (e.g., a unique identification number associated with the dairy cow **106**). Controller **110** may wait a predefined amount of time for receipt of a signal identifying the dairy cow **106** in preparation stall **112**. If a signal identifying the dairy cow **106** in preparation stall **112** is received within the predefined period of time, the method continues to step **206**. Otherwise, controller **110** may store a message in milking log **132**, the message indicating that the unidentified dairy cow **106** (1) is not to be milked, and (2) is to be sorted into catch pen **138***b* (using exit sorting gate **137**) upon exiting a milking stall **104** of rotary milking platform **102**.

At step **206**, controller **110** determines whether it is an appropriate time to milk the identified dairy cow **106** located in preparation stall **112**. For example, controller **110** may access milking log **132**, which may include the date/time that the identified dairy cow **106** was last milked. If it is determined that the amount of time elapsed since the identified dairy cow **106** was last milked is greater than a predefined amount of time, controller **110** may determine that it is an appropriate time to milk the identified dairy cow **106**. Otherwise, controller **110** may determine it is not an appropriate time to milk the identified dairy cow **106**.

If controller **110** determines at step **206** that it is an appropriate time to milk the identified dairy cow **106**, at step **208** (1) feed manger **119** (e.g., in response to a signal received from controller **110**) may dispense feed for the identified dairy cow **106**, and (2) preparation robot **116***a* (e.g., in response to a signal received from controller **110**) may position itself beneath the identified dairy cow **106** and prepare the teats of the identified dairy cow **106** for the attachment of a milking apparatus **126** (e.g., by applying a first sanitizing agent to the teats of the identified dairy cow **106**, cleaning the teats of the identified dairy cow **106**, and stimulating the teats of the identified dairy cow **106**). Preparation robot **116***a* may additionally start the attach delay timer. Once preparation robot **116***a* has prepared the teats of the dairy cow **106**, the method proceeds to step **210**. At step **210**, controller **110** may (1) generate signals to be communicated to actuators coupled exit gate **118***b* of preparation stall **112** and stall gate **117** of the milking stall located adjacent to preparation stall **112**, the communicated signals initiating the opening of exit gate **118***b* and stall gate **117** such that the identified dairy cow **106** may enter the milking stall **104** of rotary milking platform **102**, and (2) communicate a signal to feed manger **119**, the signal causing feed manger **119** to stop providing feed to the identified dairy cow **106**.

At step **212**, controller **110** determines if the identified dairy cow **106** has exited the preparation stall **112**. If the dairy cow **106** has failed to exit preparation stall **112** and enter a milking stall **104**, the method proceeds to step **214**. At step **214**, the dairy cow **106** may be pushed out of preparation stall **112** (e.g., using noise, light, or a mechanical device). If the dairy cow **106** still fails to exit preparation stall **112**, an alarm is sounded. Once the dairy cow **106** has exited the preparation stall **112** and fully entered a milking stall **104**, the method proceeds to step **216**. At step **216**, controller **110** may (1) communicate signals to the actuators coupled exit gate **118***b* and stall gate **117**, the signals initiating the closing of exit gate **118***b* and stall gate **117**, (2) communicate a signal to entrance gate **118***a* of preparation stall **112**, the signal initiating the opening of entrance gate **118***a* such that a next dairy cow **106** may enter preparation stall **112**, (3) communicate a signal to rotary drive mechanism **108**, the signal initiating an incremental rotation of rotary milking platform **102** such that the milking stall **104** in which the dairy cow **106** is located moves to a first rotational position of rotary milking platform **102** (the "attach" position), and (4) communicate a signal to feed manger **119** located in the preparation stall **112**, the signal causing feed manger **119** to open in order to attract a next dairy cow **106** to preparation stall **112**. The method then continues to step **202** where a determination is made whether a next dairy cow **106** has entered preparation stall **112**.

Returning to step **206**, if controller **110** determines that it is not an appropriate time to milk the identified dairy cow **106**, the method proceeds to step **220**. At step **220**, controller **110** may communicate a signal to an actuator coupled to sorting gate **118***c* of preparation stall **112**, the communicated signal initiating the opening of sorting gate **118***c* such that the dairy cow **106** may return to holding pen **114** to be milked at a later time. Additionally, controller **110** may communicate a signal to feed manger **119**, the signal causing feed manger **119** to close, preventing the dairy cow **106** located in the preparation stall **112** from accessing the feed. At step **222**, controller **110** determines if the dairy cow **106** has exited the preparation stall **112**. If it is determined at step **222** that the dairy cow **106** has failed to exit preparation stall **112**, the dairy cow **106** may be pushed out of preparation stall **112** (e.g., using noise, light, or a mechanical device) at step **224**. If the dairy cow **106** still fails to exit preparation stall **112**, an alarm is sounded. Alternatively, if it is determined at step **222** that the dairy cow **106** has exited the preparation stall **112**, the method proceeds to step **226**. At step **226**, controller **110** may (1) communicate a signal to the actuator coupled to sorting gate **118***c*, the signal initiating the closing of sorting gate **118***c*, (2) communicate a signal to an actuator coupled to entrance gate **118***a* of preparation stall **112**, the communicated signal initiating the opening of entrance gate **118***a*, and (3) communicate a signal to feed manger **119**, the signal causing feed manger **119** to open in order to attract another dairy cow **106** to preparation stall **112**. The method then returns to step **202**.

FIG. **3** illustrates an example method of operation **300** associated with attachment robot **116***b* of system **100**, according to certain embodiments of the present disclosure. The method begins at step **302** with a dairy cow **106** in a milking stall **104** located at a first rotational position of rotary milking platform **102** (the "attach position"). At step **304**, controller **110** determines whether a predefined attach delay period has expired. If the predefined attach delay period has not expired, the method proceeds to step **306**. At step **306**, rotary milking platform **102** remains substantially stationary and controller **110** waits for the expiration of the predefined attach delay period. Once the predefined attach delay period has expired, the method proceeds to step **308**.

At step **308**, rotary milking platform **102** remains substantially stationary and attachment robot **116***b* (e.g., in response to a signal received from controller **110**) positions itself beneath the dairy cow **106** and attaches a milking apparatus **126** to the teats of the dairy cow **106**. At step **310**, controller **110** determines whether the attachment was successful prior to the expiration of a predefined period of time. If the attachment is determined to be successful prior to the expiration of the predefined period of time, the method proceeds to step **312**.

At step **312**, controller **110** may communicate a signal to rotary drive mechanism **108**, the signal initiating a further incremental rotation of rotary milking platform **102** (e.g., an amount corresponding to a single milking stall **104**). If the attachment is determined not to be successful prior to the expiration of predefined amount of time, the method proceeds to step **314**. At step **314**, controller **110** may communicate a signal to rotary drive mechanism **108**, the signal initiating a further incremental rotation of rotary milking platform **102** (e.g., an amount corresponding to a single milking stall **104**). Additionally, at step **314** an alarm may be entered for the dairy cow **106** indicating that the attachment of milking apparatus **126** was unsuccessful (e.g., by amending milking log **132**).

FIG. **4** illustrate an example method of operation **400** associated with post dip robot **116***c* of system **100**, according to certain embodiments of the present disclosure. The method begins at step **402** with a dairy cow **106** in a milking stall **104** located at a second rotational position of rotary milking platform **102** (the "post dip position"). At step **404**, controller **110** determines whether the milking apparatus **126** previously attached to the teats of the dairy cow **106** has detached. If controller **110** determines that the milking apparatus **126** has not yet detached, the method proceeds to step **406**. At step **406**, controller **110** waits, with the rotary milking platform **102** remaining substantially stationary, for a signal indicating that the milking apparatus **126** has detached before proceeding to step **412** (described below). If controller **110** determines that the milking apparatus **126** has detached, the method proceeds to step **408**.

At step **408**, controller **110** prevents rotary milking platform **102** from advancing (i.e., rotary milking platform **102** remains substantially stationary). At step **410**, controller **110** determines if the milking apparatus **126** detached prematurely (i.e., before milking of the dairy cow **106** was complete). If controller **110** determines that the milking apparatus detached prematurely, the method proceeds directly to step **420** (described below). If controller **110** determines that the milking apparatus did not detach prematurely, the method proceeds to step **412**.

At step **412**, rotary milking platform **102** remains substantially stationary and post dip robot **116***c* (e.g., in response to a signal received from controller **110**) positions itself beneath the dairy cow **106** and applies a sanitizing agent to the teats of the dairy cow **106**. At step **414**, controller **110** communicates a signal to an actuator coupled to exit gate **136**, the signal initiating the opening of exit gate **136** such that the dairy cow **106** may exit the milking stall **104** and enter the exit pen **138**. At step **416**, a check is made to see if the dairy cow **106** has exited the milking stall **104**. If the dairy cow **106** has failed to exit the milking stall **104** within a predefined time, the dairy cow **106** may be pushed out of the milking stall **104** (e.g., using noise, light, or a mechanical device). At step **418**, controller **110** communicates a signal to the actuator coupled to exit gate **136**, the signal initiating the closing of exit gate **136**. At step **420**, controller **110** may communicate a signal to rotary drive mechanism **108**, the signal initiating a further incremental rotation of rotary milking platform **102** (e.g., an amount corresponding to a single milking stall **104**).

FIG. **5** illustrates an example method **500** of installation of the automated rotary milking system **100** depicted in FIG. **1**, according to certain embodiments of the present disclosure. The method begins at step **502**. At step **504**, first robotic device **116***a* (i.e., preparation robot **116***a*) is positioned proximate to preparation stall **112** such that preparation robot **116***a* may position itself beneath a dairy cow **106** located in preparation stall **112** in order to prepare the teats of the dairy cow **106** for the attachment of a milking apparatus **126**. At step **506**, second robotic device **116***b* (i.e., attachment robot **116***b*) is positioned at a first location proximate to rotary milking platform **102**. The first location at which attachment robot

116*b* is positioned may correspond to the location of a milking stall **104** located at a first rotational position of rotary milking platform **102** (the "attach position") such that attachment robot **116*b*** may position itself beneath a dairy cow **106** in a milking stall **104** located at the attach position in order to attach a milking apparatus **126** to the teats of the dairy cow **106**. At step **508**, third robotic device **116*c*** (i.e., post dip robot **116*c***) is positioned at a second location proximate to rotary milking platform **102**. The second location at which post dip robot **116*c*** is positioned may correspond to the location of a milking stall **104** located at a second rotational position of rotary milking platform **102** (the "post dip position") such that post dip robot **116*c*** may position itself beneath a dairy cow **106** in a milking stall **104** located at the post dip position in order to apply a sanitizing agent to the teats of the dairy cow **106**. The method ends at step **510**.

Although the steps of method **500** have been described as being performed in a particular order, the present disclosure contemplates that the steps of method **500** may be performed in any suitable order, according to particular needs.

FIG. **6** illustrates a top view of an alternative example automated rotary milking parlor system **600**, according to certain embodiments of the present disclosure. System **600** includes a rotary milking platform **102** having a number of milking stalls **104**, a rotary drive mechanism **108** coupled to the rotary milking platform **102**, a number of robotic devices **116**, and a controller **110** including control logic **134** (like-numbered components being substantially similar to those discussed above with regard to FIG. **1**).

Additionally, rather than a preparation stall **112** positioned between holding pen **114** and milking stalls **104** of rotary milking platform **102**, system **600** may include an entrance lane **140**. Entrance lane **140** may include any suitable number of walls each constructed of any suitable materials arranged in any suitable configuration operable to encourage the orderly movement of dairy cows. For example, the walls of entrance lane **140** may each include any number and combination of posts, rails, tubing, rods, connectors, cables, wires, and/or beams operable to form a substantially planar barricade such as a fence, wall, and/or other appropriate structure suitable to encourage the orderly movement of dairy cows **106**. By decreasing the effective area of holding pen **114** (e.g., using a crowd gate), the dairy cows **106** are encouraged to pass one at a time though entrance lane **140** and into milking stalls **104** of rotary milking platform **102**. Entrance lane **140** may additionally include an entrance lane gate **142** for controlling the flow of dairy cows **104** into milking stalls **104** (to prevent dairy cows **106** from becoming injured by attempting to enter a milking stall **104** while rotary milking platform **102** is rotating).

Robotic devices **116** of system **600** may include a preparation robot **116*a***, an attachment robot **116*b***, and a post dip robot **116*c***. Preparation robot **116*a*** may be positioned proximate to rotary milking platform **102** such that preparation robot **116*a*** may extend and retract from beneath a dairy cow **106** in a milking stall **104** located at a first rotational position of rotary milking platform **102** (the "preparation position"). Preparation robot **116*a*** may be operable to prepare the teats of a dairy cow **106** in the milking stall **104** located at the preparation position for the attachment of a milking apparatus **126** (e.g., by applying a first sanitizing agent to the teats of the dairy cow **106**, cleaning the teats of the dairy cow **106**, and stimulating the teats of the dairy cow **106**).

Attachment robot **116*b*** may positioned proximate to rotary milking platform **102** such that attachment robot **116*b*** may extend and retract from beneath a dairy cow **106** located in a milking stall **104** located at a second rotational position of rotary milking platform **102** (the "attach position"). Attachment robot **116*b*** may be operable to perform functions including attaching a milking apparatus **126** to the teats of a dairy cow **106** in the milking stall **104** located at the attach position. The milking apparatus **126** may be stored beneath the floor of the milking stall **104** (or at any other suitable location) such that the milking apparatus is accessible by attachment robot **116*b***.

Post dip robot **116*c*** may be positioned proximate to rotary milking platform **102** such that post dip robot **116*c*** may extend and retract from beneath a dairy cow **106** located in a milking stall **104** located at a third rotational position of rotary milking platform **102** (the "post dip position"). Post dip robot **116*c*** may be operable to perform functions including applying a sanitizing agent to the teats of a dairy cow **106** in the milking stall **104** located at the post dip position. Each of the above-described functions performed by preparation robot **116*a***, attachment robot **116*b***, and post dip robot **116*c*** may be performed while rotary milking platform **102** is substantially stationary (as controlled by controller **110** in conjunction with rotary drive mechanism **108**, as described in further detail below).

In certain embodiments, various components of system **600** (e.g., rotary drive mechanism **108** and robotic devices **116**) may each be communicatively coupled (e.g., via a network facilitating wireless or wireline communication) to controller **110**, which may initiate/control the automated operation of those devices (as described in further detail below). In certain embodiments, controller **110** may include control logic **134** (e.g., stored memory module **130**), which may include any information, logic, and/or instructions stored and/or executed by controller **110** to control the automated operation of system **600**, as described below. For example, in response to control logic **134**, processor **128** may (1) communicate signals to actuators coupled to gates (e.g., exit gate **136**) to initiate opening/closing of those gates, (2) communicate signals to rotary drive mechanism **108** to initiate the starting/stopping of rotary milking platform **102**, and (3) communicate signals to robotic devices **116** to initiate performance of the above-described functions associated with those robotic devices **116**.

In operation of an example embodiment of system **600**, controller **110** may receive a signal indicating that a dairy cow **106** has entered a milking stall **104** of rotary milking platform **102** (e.g., from a presence sensor or from any other suitable component of system **600**). Additionally, controller **110** may receive a signal from identification device **120** and may include the identity (e.g., tag number) of the dairy cow **106**. Once the identified dairy cow **106** has fully entered a milking stall **104**, controller **110** may communicate signals to actuators coupled to entrance lane gate **142** and stall gate **117**, the signals causing entrance lane gate **142** and stall gate **117** to close. Additionally, controller **110** may communicate a signal to rotary drive mechanism **108**, the signal initiating an incremental rotation of rotary milking platform **102** such that the milking stall **104** in which the identified dairy cow **106** is located moves to a first rotational position of rotary milking platform **102** (the "preparation" position).

With the rotary milking platform **102** being substantially stationary and the milking stall **104** of the identified dairy cow **106** being located at the preparation position, preparation robot **116*a*** (e.g., in response to a signal received from controller **110**) may position itself beneath the identified dairy cow **106** and prepare the teats of the identified dairy cow **106** for the attachment of a milking apparatus **126** (e.g., by applying a sanitizing agent to the teats of the identified dairy cow **106**, cleaning the teats of the identified dairy cow **106**, and stimulating the teats of the identified dairy cow **106**). Once preparation robot **116***a* has prepared the teats of the identified dairy cow **106** (and possibly after a next dairy cow **106** has fully entered a milking stall **104**, as described above), controller **110** may communicate a signal to rotary drive mechanism **108**, the signal initiating a further incremental rotation of rotary milking platform **102** (e.g., an amount corresponding to a single milking stall **104**) such that the milking stall **104** of the identified dairy cow **106** moves from the first rotational position of rotary milking platform **102** (the "preparation" position) to a second rotational position of rotary milking platform **102** (the "attach" position).

With the rotary milking platform **102** being substantially stationary and the milking stall **104** of the identified dairy cow **106** being located at the attach position, attachment robot **116***b* (e.g., in response to a signal received from controller **110**) may position itself beneath the identified dairy cow **106** and attach a milking apparatus **126** to the teats of the identified dairy cow **106**. For example, attachment robot **116***b* may access a milking apparatus **126** corresponding to the milking stall **104** of the identified dairy cow **106** from a known storage position within the milking stall **104** (e.g., beneath the floor of the milking stall **104**) and attach the accessed milking apparatus **126** to the teats of the identified dairy cow **106**.

Once attachment robot **116***b* has attached the milking apparatus **126** to the teats of the identified dairy cow **106** (and possibly after preparation robot **116***a* has completed preparing the teats of a next dairy cow **106** for the attachment of a milking apparatus **126**, as described above), controller **110** may communicate a signal to rotary drive mechanism **108**, the signal initiating a further incremental rotation of rotary milking platform **102** (e.g., an amount corresponding to a single milking stall **104**). As rotary milking platform **102** completes subsequent incremental rotations, the identified dairy cow **106** is milked, with the milking apparatus **126** being detached and withdrawn (e.g., by retracting the milking apparatus **126** to the known storage position within the milking stall **104**) once milking is complete. With milking complete, the identified dairy cow **106** continues to complete incremental rotations until the milking stall **104** in which the identified dairy cow **106** is located reaches a third rotational position (the "post dip position").

With the rotary milking platform **102** being substantially stationary and the milking stall **104** of the identified dairy cow **106** being located at the post dip position, post dip robot **116***c* (e.g., in response to a signal received from controller **110**) may position itself beneath the identified dairy cow **106** and apply a sanitizing agent to the teats of the identified dairy cow **106**. In certain embodiments, the post dip position may be located proximate to an exit gate **136** leading to an exit pen **138**. Once post dip robot **116***c* has applied the sanitizing agent, controller **110** may communicate a signal to an actuator coupled to exit gate **136**, the signal initiating the opening of exit gate **136** such that the identified dairy cow **106** may exit the milking stall **104** and enter the exit pen **138**. If, however, controller **110** determines either that the identified dairy cow **106** was not fully milked or that the milking apparatus **126** was detached prematurely (e.g., using historical milking data stored in milking log **132**), a signal may not be communicated to the actuator coupled to exit gate **136**, forcing the identified dairy cow **106** to complete another milking rotation (as described above).

Although a particular implementation of system **600** is illustrated and primarily described, the present disclosure contemplates any suitable implementation of system **600**, according to particular needs. Moreover, although robotic devices **116** of system **600** have been primarily described as being located at particular positions relative to milking platform **102**, the present disclosure contemplates robotic devices **116** being positioned at any suitable locations, according to particular needs.

FIG. **7** illustrates an example method **700** of installation of the automated rotary milking system **600** depicted in FIG. **6**, according to certain embodiments of the present disclosure. The method begins at step **702**. At step **704**, first robotic device **116***a* (i.e., preparation robot **116***a*) is positioned at a first location proximate to rotary milking platform **102**. The first location at which preparation robot **116***a* is positioned may correspond to the location of a milking stall **104** located at a first rotational position of rotary milking platform **102** (the "preparation position") such that preparation robot **116***a* may position itself beneath a dairy cow **106** located in preparation stall **112** in order to prepare the teats of the dairy cow **106** for the attachment of a milking apparatus **126**.

At step **706**, second robotic device **116***b* (i.e., attachment robot **116***b*) is positioned at a second location proximate to rotary milking platform **102**. The second location at which attachment robot **116***b* is positioned may correspond to the location of a milking stall **104** located at a second rotational position of rotary milking platform **102** (the "attach position") such that attachment robot **116***b* may position itself beneath a dairy cow **106** in a milking stall **104** located at the attach position in order to attach a milking apparatus **126** to the teats of the dairy cow **106**.

At step **708**, third robotic device **116***c* (i.e., post dip robot **116***c*) is positioned at a third location proximate to rotary milking platform **102**. The third location at which post dip robot **116***c* is positioned may correspond to the location of a milking stall **104** located at a third rotational position of rotary milking platform **102** (the "post dip position") such that post dip robot **116***c* may extend beneath a dairy cow **106** in a milking stall **104** located at the post dip position in order to apply a sanitizing agent to the teats of the dairy cow **106**. The method ends at step **710**.

Although the steps of method **700** have been described as being performed in a particular order, the present disclosure contemplates that the steps of method **700** may be performed in any suitable order, according to particular needs.

FIG. **8** illustrates a top view of an additional alternative example automated rotary milking parlor system **800**, according to certain embodiments of the present disclosure. System **800** includes a rotary milking platform **102** having a number of milking stalls **104**, a rotary drive mechanism **108** coupled to the rotary milking platform, a single robotic device **116**, and a controller **110** including control logic **134** (like-numbered components being substantially similar to those discussed above with regard to FIG. **1**).

Additionally, rather than a preparation stall **112** positioned between holding pen **114** and milking stalls **104** of rotary milking platform **102**, system **800** may include an entrance lane **140**. Entrance lane **140** may include any suitable number of walls each constructed of any suitable materials arranged in any suitable configuration operable to encourage the orderly movement of dairy cows **106**. For example, the walls of entrance lane **140** may each include any number and combination of posts, rails, tubing, rods, connectors, cables, wires, and/or beams operable to form a substantially planar barricade such as a fence, wall, and/or other appropriate structure suitable to encourage the orderly movement of dairy cows **106**. By decreasing the effective area of holding pen **114** (e.g., using a crowd gate), the dairy cows **106** are encouraged to pass one at a time though entrance lane **140** and into milking stalls **104** of rotary milking platform **102**. Entrance lane **140** may additionally include an entrance lane gate **142** for controlling the flow of dairy cows **104** into milking stalls **104** (to prevent dairy cows **106** from becoming injured by attempting to enter a milking stall **104** while rotary milking platform **102** is rotating).

The single robotic device **116** of system **800** may be positioned proximate to rotary milking platform **102** such that the single robotic device **116** may (1) extend and retract from beneath a dairy cow **106** in a milking stall **104** located at a first rotational position of rotary milking platform **102** (the "preparation position"), (2) extend and retract from beneath a dairy cow **106** located in a milking stall **104** located at a second rotational position of rotary milking platform **102** (the "attach position"), and (3) extend and retract from beneath a dairy cow **106** located in a milking stall **104** located at a third rotational position of rotary milking platform **102** (the "post dip position").

With regard to a dairy cow **106** in a stall **104** located at the preparation position, the single robotic device **116** may be operable to prepare the teats of a dairy cow **106** located in the milking stall **104** located at the preparation position for the attachment of a milking apparatus **126** (e.g., by applying a sanitizing agent to the teats of the dairy cow **106**, cleaning the teats of the dairy cow **106**, and stimulating the teats of a dairy cow **106**).

With regard to a dairy cow **106** in a stall **104** located at the attach position, the single robotic device **116** may be operable to perform functions including attaching a milking apparatus **126** to the teats of a dairy cow **106** in the milking stall **104** located at the attach position. The milking apparatus **126** may be located beneath the floor of the milking stall **104** located at the first rotational position of rotary milking platform **102** (or at any other suitable location) such that the milking apparatus **126** is accessible by the single robotic device **116**.

With regard to a dairy cow **106** in a stall **104** located at the post dip position, the single robotic device **116** may be operable to perform functions including applying a sanitizing agent to the teats of a dairy cow **106** in the milking stall **104** located at the post dip position. Each of the above-described functions performed by the single robotic device **116** may be performed while rotary milking platform **102** is substantially stationary (as controlled by controller **110** in conjunction with rotary drive mechanism **108**, as described in further detail below).

In certain embodiments, various components of system **800** (e.g., rotary drive mechanism **108** and single robotic device **116**) may each be communicatively coupled (e.g., via a network facilitating wireless or wireline communication) to controller **110**, which may initiate/control the automated operation of those devices (as described in further detail below). In certain embodiments, controller **110** may include control logic **134** (e.g., stored memory module **130**), which may include any information, logic, and/or instructions stored and/or executed by controller **110** to control the automated operation of system **800**, as described below. For example, in response to control logic **134**, processor **128** may (1) communicate signals to actuators coupled to gates (e.g., exit gate **136**) to initiate opening/closing of those gates, (2) communicate signals to rotary drive mechanism **108** to initiate the starting/stopping of rotary milking platform **102**, and (3) communicate signals to the single robotic device **116** to initiate performance of the above-described functions associated with single robotic device **116**.

In operation of an example embodiment of system **800**, controller **110** may receive a signal indicating that a dairy cow **106** has entered a milking stall **104** of rotary milking platform **102** (e.g., from a presence sensor or from any other suitable component of system **800**). Additionally, controller **110** may receive a signal from identification device **120** and may include the identity (e.g., tag number) of the dairy cow **106**. Once the identified dairy cow **106** has fully entered a milking stall **104**, controller **110** may communicate a signal to an actuator coupled to entrance lane gate **142**, the signal causing entrance lane gate **142** to close. Additionally, controller **110** may communicate a signal to rotary drive mechanism **108**, the signal initiating an incremental rotation of rotary milking platform **102** such that the milking stall **104** in which the identified dairy cow **106** is located moves to a first rotational position of rotary milking platform **102** (the "preparation" position).

With the rotary milking platform **102** being substantially stationary and the milking stall **104** of the identified dairy cow **106** being located at the preparation position, the single robotic device **116** (e.g., in response to a signal received from controller **110**) may position itself beneath the identified dairy cow **106** and prepare the teats of the dairy cow **106** for the attachment of a milking apparatus **126**. In addition, the single robotic device **116** may (1) position itself beneath a dairy cow **106** in a milking stall **104** located at the attach position in order to attach a milking apparatus **126** to the teats of that dairy cow **106**, and (2) position itself beneath a dairy cow **106** in a milking stall **104** located at the post dip position in order to apply a sanitizing agent to the teats of that dairy cow **106**. Once the single robotic device **116** has performed each of these functions (and possibly after a next dairy cow **106** has fully entered a milking stall **104**, as described above), controller **110** may communicate a signal to rotary drive mechanism **108**, the signal initiating a further incremental rotation of rotary milking platform **102** (e.g., an amount corresponding to a single milking stall **104**) such that the milking stall **104** of the identified dairy cow **106** moves from the first rotational position of rotary milking platform **102** (the "preparation" position) to a second rotational position of rotary milking platform **102** (the "attach" position).

With the rotary milking platform **102** being substantially stationary and the milking stall **104** of the identified dairy cow **106** being located at the attach position, the single robotic device **116** (e.g., in response to a signal received from controller **110**) may position itself beneath the identified dairy cow **106** and attach a milking apparatus **126** to the teats of the identified dairy cow **106**. For example, the single robotic device **116** may access a milking apparatus **126** corresponding to the milking stall **104** of the identified dairy cow **106** from a known storage position within the milking stall **104** (e.g., beneath the floor of the milking stall **104**) and attach the accessed milking apparatus **126** to the teats of the identified dairy cow **106**. In addition, the single robotic device **116** may (1) position itself beneath a dairy cow **106** in a milking stall **104** located at the preparation position in order to prepare the teats of that dairy cow **106** for the attachment of a milking apparatus **126**, and (2) position itself beneath a dairy cow **106** in a milking stall **104** located at the post dip position in order to apply a sanitizing agent to the teats of that dairy cow **106**. Once the single robotic device **116** has performed each of these functions (and possibly after a next dairy cow **106** has fully entered a milking stall **104**, as described above), controller **110** may communicate a signal to rotary drive mechanism **108**, the signal initiating a further incremental rotation of rotary milking platform **102** (e.g., an amount corresponding to a single milking stall **104**).

As rotary milking platform **102** completes subsequent incremental rotations, the identified dairy cow **106** is milked, with the milking apparatus **126** being detached and withdrawn (e.g., by retracting the milking apparatus **126** to the known storage position within the milking stall **104**) once milking is complete. With milking complete, the identified dairy cow **106** continues to complete incremental rotations until the milking stall **104** in which the identified dairy cow **106** is located reaches a third rotational position (the "post dip position"). With the rotary milking platform **102** being substantially stationary and the milking stall **104** of the identified dairy cow **106** being located at the post dip position, the single robotic device **116** (e.g., in response to a signal received from controller **110**) may position itself beneath the identified dairy cow **106** and apply a sanitizing agent to the teats of the identified dairy cow **106**. In addition, the single robotic device **116** may (1) position itself beneath a dairy cow **106** in a milking stall **104** located at the preparation position in order to prepare the teats of that dairy cow **106** for the attachment of a milking apparatus **126**, and (2) position itself beneath a dairy cow **106** in a milking stall **104** located at the attach position in order to attach a milking apparatus **126** to the teats of that dairy cow **106**.

In certain embodiments, the post dip position may be located adjacent to an exit gate **136** leading to an exit pen **138**. Once single robotic **116** has applied the sanitizing agent, controller **110** may communicate a signal to an actuator coupled to exit gate **136**, the signal initiating the opening of exit gate **136** such that the identified dairy cow may exit the milking stall **104** and enter the exit pen **138**. If, however, controller **110** determines either that the identified cow was not fully milked or that the milking apparatus was detached prematurely (e.g., using historical milking data stored in milking log **132**), a signal may not be communicated to the actuator coupled to exit gate **136**, forcing the identified dairy cow **106** to complete another milking rotation (as described above).

Although a particular implementation of system **800** is illustrated and primarily described, the present disclosure contemplates any suitable implementation of system **800**, according to particular needs. Moreover, although the single robotic devices **116** of system **800** has been primarily described as being located at a particular position relative to milking platform **102**, the present disclosure contemplates the single robotic device **116** being positioned at any suitable location, according to particular needs.

Although the present invention has been described with several embodiments, diverse changes, substitutions, variations, alterations, and modifications may be suggested to one skilled in the art, and it is intended that the invention encompass all such changes, substitutions, variations, alterations, and modifications as fall within the spirit and scope of the appended claims.

What is claimed is:

1. A milking system, comprising:

a rotary milking platform having a plurality of milking stalls;

a plurality of milking devices, each milking device configured for attachment to the teats of a dairy livestock located in a corresponding milking stall of the rotary milking platform;

a first robotic device operable to prepare the teats of a first dairy livestock while the first dairy livestock is located in a first milking stall of the rotary milking platform;

a second robotic device operable to attach a milking apparatus to the teats of a second dairy livestock while the second dairy livestock is located in a second milking stall of the rotary milking platform;

a third robotic device operable to apply a sanitizing agent to the teats of a third dairy livestock while the third dairy livestock is located in a third milking stall of the rotary milking platform; and

a controller that controls the operation of the second robotic device based at least in part upon a milking log that stores information regarding the amount of time that has elapsed since the last time the second dairy livestock was milked and whether an amount of milk collected from the second dairy livestock during a previous time period is less than a predefined threshold associated with the second dairy livestock.

2. The system of claim **1**, wherein preparing the teats of a dairy livestock comprises:

applying a sanitizing agent to the teats of the dairy livestock;

cleaning the teats of the dairy livestock; and

stimulating the teats of the dairy livestock.

3. A method, comprising:

preparing the teats of a dairy livestock located in a milking stall of a rotary milking platform using a first robotic device;

attaching a milking apparatus to the teats of the dairy livestock using a second robotic device while the dairy livestock is located in the milking stall of the rotary milking platform;

applying a sanitizing agent to the teats of the dairy livestock using a third robotic device while the dairy livestock is located in the milking stall of the rotary milking platform; and

controlling the operation of at least one of the first robotic device, the second robotic device, and the third robotic device based at least in part upon a milking log that stores information regarding the amount of time that has elapsed since the last time the dairy livestock was milked and whether an amount of milk collected from the dairy livestock during a previous time period is less than a predefined threshold associated with the dairy livestock.

4. The method of claim **3**, wherein preparing the teats of a dairy livestock comprises:

applying a sanitizing agent to the teats of the dairy livestock;

cleaning the teats of the dairy livestock; and

stimulating the teats of the dairy livestock.

5. A method, comprising:

positioning a first robotic device at a first location proximate to a rotary milking platform having a plurality of milking stalls, the first robotic device operable to prepare the teats of a first dairy livestock while the first dairy livestock is in a first milking stall of the rotary milking platform;

positioning a second robotic device at a second location proximate to the rotary milking platform, the second robotic device operable to attach a milking apparatus to the teats of a second dairy livestock while the second dairy livestock is located in a second milking stall of the rotary milking platform;

positioning a third robotic device at a third location proximate to the rotary milking platform, the third robotic device operable to apply a sanitizing agent to the teats of a third dairy livestock while the third dairy livestock is in a third milking stall of the rotary milking platform; and

controlling the operation of the second robotic device based at least in part upon a milking log that stores information regarding the amount of time that has elapsed since the last time the second dairy livestock was milked and whether an amount of milk collected from the second dairy livestock during a previous time period is less than a predefined threshold for the second dairy livestock.

6. The method of claim 5, wherein preparing the teats of the first dairy livestock comprises:

applying a sanitizing agent to the teats of the first dairy livestock;

cleaning the teats of the first dairy livestock; and

stimulating the teats of the first dairy livestock.

7. A method, comprising:

preparing, using a first robotic device, the teats of a first dairy livestock for the attachment of a milking apparatus while the first dairy livestock is located in a first milking stall of a rotary milking platform;

attaching, using a second robotic device, a milking apparatus to the teats of a second dairy livestock while the second dairy livestock is located in a second milking stall of a rotary milking platform;

applying, using a third robotic device, a sanitizing agent to the teats of a third dairy livestock while the third dairy livestock is located in a third milking stall of the rotary milking platform; and

controlling the operation of the second robotic device based at least in part upon a milking log that stores information regarding the amount of time that has elapsed since the last time the second dairy livestock was milked and whether an amount of milk collected from the second dairy livestock during a previous time period is less than a predefined threshold for the second dairy livestock;

wherein:

the first robotic device is positioned at a first location adjacent to the rotary milking platform;

the second robotic device is positioned at a second location adjacent to the rotary milking platform;

the third robotic device is positioned at a third location adjacent to the rotary milking platform.

8. The method of claim 7, wherein preparing the teats of the first dairy livestock comprises:

applying a sanitizing agent to the teats of the first dairy livestock;

cleaning the teats of the first dairy livestock; and

stimulating the teats of the first dairy livestock.

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